U. S. Department of Energy

Scoring Criteria for Applied R&D Investments

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Question 1a: To what extent does the R&D activity support an area identified by the President as a high priority?

Grade 5: The President or the Executive Office of the President specifically directs a major portion of the R&D activity, or the activity addresses a specific security goal outlined as one of the Secretary's priorities.

(Example: Implements an Executive Order -- cite by name, number and date)

(FE example: The Clean Coal Power Initiative implements the President's initiative to fund Clean Coal Technology research)

Grade 4: A major portion of the R&D activity is specifically recommended in the National Energy Policy (NEP) and supports the President's energy policy; by National Security Directives; or, by the Secretary.

(FE example: The first two recommendations in Chapter 5 of the NEP call for the promotion of new technology for oil and gas exploration, and for enhanced recovery from existing wells.)

(NE example: NE's R&D activities to develop nuclear waste transmutation technologies include a cooperative agreement with France that implements the NEP's recommendation to consider technologies, in collaboration with international partners with highly developed fuel cycles and a record of close cooperation to develop reprocessing and fuel treatment technologies that are cleaner, more efficient, less waste-intensive and more proliferation-resistant.)

Grade 3: The R&D activity is part of an applied R&D portfolio indirectly referenced in, and highly significant to the NEP or National Security Directives; is highly significant to energy and/or nuclear security; is part of a balanced portfolio of activities to increase national security; or, responds to other clearly articulated Administration priorities.

(Example: The Secretary's Top-to-Bottom review of the Environmental Management program)

Grade 2: The R&D activity addresses Administration policy/planning documents other than the NEP, National Security Directives or the Secretary's goals. The activity is part of a portfolio that will enhance the security and/or reliability of the Nation's energy supply.

Grade 1: The R&D activity is not a current Presidential/Administration priority; priority is unknown; or, no data is available.

(Example: While Program "X" is a long-standing program, Program "X" has not been cited in Presidential or Administration documents or speeches.)

Question 1b: To what extent are there market barriers to private sector investment in research related to the effort?

Grade 5: High Risk - Substantial initial capital investment is required, or other substantial market barrier(s) to private sector investment exist which jeopardize the ability of private industry to make the necessary technology improvements; or, public law or Federal policy precludes private sector involvement.

(EERE example 1: A market for the use of hydrogen as an energy supply does not exist. Research is fundamental and highly risky.)

(EERE example 2: Market barriers for Advanced Photovoltaics (PV) include: lack of real-time pricing in electricity markets; the high-risk nature of the research on these systems; and the fact that the niche commercial markets which exist are insufficient to sustain the research levels necessary to achieve fundamental breakthroughs in PV design.

(EM example: DOE is the major market for the research, e.g. nuclear waste management.)

(FE example: Most technology options for large-scale carbon sequestration are dependent on imposition of regulation designed to significantly reduce carbon emissions, and the Administration has not announced any policy to seek such regulation in the future.)

Grade 4: Medium Risk - Specific market barriers exist which result in sub-optimum private sector investment and delayed commercialization.

(NE example: The new Early-Site Permit and combined Construction and Operating License processes for nuclear power plants pose substantial cost and schedule risks, i.e., market barriers)

Grade 3: Medium to Low Risk - The industry is widely believed to face at least one market barrier, and any existing market experience with current generation technologies is too limited, specialized or rudimentary to provide significant opportunities for overcoming this barrier. Some companies would be willing to invest in the R&D activity, as the necessary capital investment is not prohibitive.

Grade 2: Low Risk - The industry is widely believed to face at least one of the market barriers identified above, but the technology under development is in the demonstration phase and commercialization has begun.

(EERE example - Compact florescent light bulbs: Continued improvements, but improvements are incremental and market is well established.)

Grade 1: No specific barriers have been identified; it is expected that low risk and low capital investment would be required. Most companies would be willing to invest in the R&D activity.

Definitions for question 1b:

The following types of market barriers to private sector investments are generally recognized in the literature.

Externalities, regulatory distortions, subsidies available to competitors, etc., create a price disincentive to private sector investment. (Example: Current electricity price regulation typically prevents consumers from being charged the full marginal cost of peak electricity use, reducing incentives to develop peak-reducing products.) Externalities occur when producers or consumers exert uncompensated costs on others. Classic examples of externalities include uncompensated for or uncontrolled environmental damages and national security costs.

Specific regulations prevent or discourage sound R&D investments. (Example: conflicting State requirements for technology usage.)

The industry (or industries) lacks (or lack) the structure necessary to effectively undertake needed research due to small size, geographically limited operations, or fragmentation of firms addressing varying aspects of the research. These conditions often result in smaller-than-average or volatile profit margins. (Example: Integrated home design technology requires coordination of hundreds of materials suppliers, architects and builders.)

The nature of the research is such that the companies making the R&D investments could realize little or any of the technology benefits. (Example: The research is at a relatively basic stage and it would be extremely difficult for a firm to successfully patent the results. The risk-to-return ratio or time frame for the research proposed exceeds typical private research investment practices for the industry at hand.

Note: *Technology transfer risks are also examples of a substantial market barrier to private sector investment. For example, in the case of gaseous diffusion/gas centrifuge technology being developed by NE, the technology in its present form is highly classified and/or must be carefully configured to avoid the potential for reverse engineering. Because of the high national security risk, the development for commercial applications will take more time that can be absorbed into a normal commercial/business venture.*

Question 1c: To what extent does the R&D activity support work where there is a clear public benefit?

Grade 5: A clear national public benefit with quantifiable outcomes that would be realized if the research were successful, or the R&D activity responds to a pressing national need clearly identified by the President

(Example: Annual reduction of NOx emissions by 614,000 tons, contributing to a "three-pollutant" policy).

(NE example: In combination with Nuclear Power 2010 and the NERI and I-NERI programs, the Generation IV program will avoid 81 million metric tons of greenhouse gas emissions annually that would result from the production of the same 50,000 MW of electricity by fossil fuel.)

Grade 4: A broad public benefit would be realized if research is successful. Benefits have been documented, are readily identified, and are measurable.

(EERE example: Electricity technologies designed to help utilities work with customers to directly reduce the likelihood of electricity disruptions to all classes of customers in the many areas of the county with old, insufficient transmission and distribution systems)

(EM example: Improvements to environmental restoration and waste management technologies can accelerate environmental cleanup and prevent future contamination.)

(NE example: The reduction of nuclear waste toxicity by transmutation, being studied by NE, is expected to reduce public concern and increase the feasibility of high-level nuclear waste management.)

Grade 3: The chief direct beneficiaries are individual companies, but clear national benefits can be realized.

Grade 2: Localized public benefits may be realized, but are likely to be limited or are not readily measurable.

Grade 1: The public benefits are negligible or unknown.

Definitions for 1c:

The following types of public benefits are widely recognized in the literature:

Public goods (not currently supported by the marketplace): The most common forms of market failure include imperfect competition, the existence of externalities, or the existence of public goods. Many (but by no means all) economists believe that public goods, by nature, must be provided by the government. A key feature of public goods is that they must be provided on a non-exclusive basis. Non-excludable public goods are benefits that are generally available to any or all citizens. Such goods available to all citizens include national defense, criminal justice, and environmental benefits. The distinguishing feature of these goods is that they provide benefits to all individuals, and once the goods are produced it is impossible (or at least very costly) to exclude anyone from benefiting from them.

Most goods are not purely non-excludable, but rather have some element of a public goods nature, e.g. they are partially non-excludable. For example, many roadways fall into this category; even if tolls are charged, congestion may limit use. Some goods, like public parks, can become exclusionary by charging fees or issuing passes, but can also have "public goods" components related to their "existence value," e.g. the fact that people may prefer to have environmental amenities, even if they don't intend to use them personally.

Research and development activities focusing on basic or pre-commercial investigations are likely to have a larger "public goods" component than those focusing on the development of proprietary technologies.

Public goods are often "non-rival" goods as well. A non-rival good is one where consumption by one individual does not deplete the supply available for consumption by other individuals. For example, information is a non-rival good. Patents are an attempt to turn this non-rival good into an excludable good.

Overall economic improvements (not achievable through the private sector): The public nature of economic improvement is more difficult to establish. Economic improvements are public in nature when they involve the economy as a whole. These can take the form of reduced costs of goods and services, such as energy services; reduced costs of production; or the price-dampening effect of reduced demand, where market prices are sensitive to demand. Large improvements in the Nation's balance-of-trade (as distinct from improved trade conditions for a single industry) provide economic improvements to the nation. Scientific advances can provide general economic improvements when they have broad applications throughout the economy. Government establishment of uniform weights and measures, and similar types of protocols can provide general, public economic improvements by providing a stronger basis for markets to function.

Question 1d: To what extent does the R&D activity most effectively support the Federal policy goals compared to other policy alternatives such as legislation or regulation?

***Notes**:*

> *1. DOE will use a 5-3-1 scoring alternative, as it provides sufficient differentiation on this question.*
>
> *2. Measures of "most effectively" can have several dimensions, e.g. having the largest impact on realizing Federal policy goals, or resulting in the least cost for Federal taxpayers.*

Grade 5: The issue of whether existing and proposed legislation, regulations or other types of policies could solve the problem has been carefully examined. The R&D activity fully supports a Federal policy goal or goals that is (are) not likely to be satisfactorily addressed by other policy alternatives such as legislation or regulation. The research effort would increase the effectiveness of, or otherwise complement existing or proposed legislation, regulations or other types of policies.

(Example: R&D activities supporting the NNSA's science-based approach to certifying the safety and reliability of the U.S. nuclear weapons stockpile.)

(NE example: Nuclear Power 2010 cost-shared R&D is an integral component of Federal actions required to deploy new nuclear power plants and would benefit from industry incentives (e.g., tax credits and loan guarantees) to reduce the financial and regulatory risks.)

Grade 3: The issue of whether existing and proposed legislation and/or regulations could solve the problem has been carefully examined, and it is unclear whether R&D is preferable to other likely policy approaches.

***Note**: For national security programs driven by Federal policy mandates, examination of legislative relief is often not appropriate.*

(Example: R&D activity partially supports Federal policy goals.)

Grade 1: The R&D activity supports a Federal policy goal where the research effort could be of some help, but it is very likely that the goal could be achieved more readily and cost-effectively by modifying existing regulations or legislation.

Question 2a: How well does the plan build on existing technology, complement related R&D activities, and propose technically feasible R&D activities?

Grade 5: A comprehensive multi-year R&D plan has been developed and clearly identifies existing technologies upon which it builds; research is integral to the portfolio, and part of/based on a roadmap of technological research; clearly identifies other areas of research dependent upon its results or upon which it depends for its success; has identifiable schedule milestones and objectives that demonstrate the technical feasibility of the R&D activity; and is clearly critical to success of portfolio objectives.

(Example 1: An NAS study documents technical feasibility and the research plan indicates that success is dependent upon work being undertaken elsewhere related to the properties of the materials to be used.)

(Example 2: NNSA proposes a technically feasible project and, depending upon the R&D activity, industry will be involved in some aspect, but not necessarily in project planning.)

(Example 3: For EERE's R&D on advanced technologies such as white light LEDs, it is not known *a priori* if the technology can be successfully developed, but the basic physics appears to be technically feasible.

Grade 4: The multi-year R&D plan is integral to the overall program portfolio; research builds on existing knowledge of the technology; complements related R&D activities; proposes technically feasible R&D activities; and, has identifiable schedule milestones and objectives.

Grade 3: Higher-level strategies and roadmaps are meritorious but not comprehensive in recognizing synergies or possible duplication. The plan addresses all three issues (existing technology, technical feasibility, and related research), but does not identify clear milestones and objectives.

Grade 2: The plan only addresses 1 or 2 of the 3 issues (existing technology, technical feasibility, and related research), or only minimally addresses all three.

Grade 1: None of the three issues are adequately addressed. The plan does not adequately explain how the R&D effort builds on existing technology, is technically feasible, or complements related R&D activities.

Question 2b: How well does the R&D activity's planning and prioritization incorporate industry involvement?

Grade 5: A broad representation of industry R&D stakeholders (e.g. potential producers, vendors, and users of the technology; peer review experts; and/or standing advisory committees*****) participated in development of a technology roadmap outlining and prioritizing future research. Industry participated in the development of the R&D activity schedule, milestones, objectives, and transition points to the private sector. Industry experts have been involved in assessing the technical and economic merits of multi-year R&D plans within the last 5 years.

***** The Nuclear Energy Research Advisory Committee (NERAC), for example.

(EERE example: EERE's past work on electronic ballasts for lighting involved industry; however, the work was not constrained by the efforts of some companies to prevent this advanced technology from moving into the market and impacting their sales of inefficient magnetic ballasts. This work generated large public benefits as identified by the National Academy of Sciences.)

(EM example: EM R&D plan is developed in conjunction with both the contractor and the DOE site management.)

(FE example: A group of experts from industry and academia meet offsite twice a year to review advanced coal power programs, including strategic drivers, risk, and program objectives and timing. Roadmaps have been developed in concert with industry R&D stakeholders for major program areas.)

(NE example: The Generation IV Nuclear Energy Systems Initiative Technology Roadmap is being developed by NERAC using approximately 100 U.S. and international experts from industry, academia, the national laboratories, and foreign organizations.)

Grade 4: Ad hoc experts from industry generally participated throughout the planning and prioritization process, and in the assessment of technological and economic risk, but representation was/is informal, or the breadth of the industry was/is not well represented.

Grade 3: Industry was involved in planning and prioritization, but involvement was both informal and narrow in its representation. R&D activities are selected from government-industry roadmaps/portfolios that have been reviewed in the last 5 years.

Grade 2: Industry was only marginally consulted during R&D activity planning and prioritization.

Grade 1: Industry was not involved in any aspect of R&D activity planning or prioritization, or no documentation of involvement can be provided.

Definitions for 2b:

Industry: For Environmental Management, "industry" is defined as the clean-up contractors at the DOE sites and technology vendors.

Question 2c: What is the level of industry cost sharing for the program?

The level of cost sharing by industry is ____________%

Notes:

1. *This will be a "fill-in-the-blank" question and will not be subject to scoring*

2. *When cost sharing is low or might appear to be inappropriate, the reason should be addressed in the narrative documentation that accompanies the R&D scoring.*

   (NE example: For the nuclear waste transmutation R&D activity, cost sharing by industry is negligible. The Nuclear Waste Policy Act of 1982 makes the Federal government responsible for the management of high-level nuclear waste and cost-sharing would, therefore, not be expected.)

3. *Sometimes data on cost sharing is not available. For example, Fossil Energy's Clean Coal Initiative, a new Presidential Initiative, has not yet selected any R&D activities, and is not likely to do so for many months. Making a judgment on cost sharing under these circumstances is difficult, so the supporting narrative that accompanies the score is critical.*

4. *The Energy Policy Act of 1992 has a minimum threshold of 20 percent cost sharing for R&D (between Basic Research and Demonstration.) It should be noted that many of the Department's R&D activities are not covered by the Act.*

Definitions for question 2c:

Note: *OMB definitions, where available, are provided.*

Basic Research: Basic research is defined as systematic study directed toward fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind.
(OMB definition)

Applied Research: Applied research is defined as systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met. (OMB definition)

Basic Research contrasted with Applied Research: Basic research is the expansion of knowledge that may benefit the U.S. in future years, while applied research is based on solving specific problems in a definable time frame.

Development: Development is defined as systematic application of knowledge or understanding, directed toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements. (OMB Definition)

(Example: Stationary Fuel Cells)

Demonstration: The operation and evaluation, at commercial or semi-works scale (see definition below), of processes, technologies or systems to assess: technological effectiveness; costs to verify and quantify feasibility of construction; operability; maintainability; durability; and, economics, prior to decision-making on further replication, deployment, or marketing.

(Example: FE's Clean Coal Power initiative).

Semi-works Scale: Operation on a limited commercial scale to provide final tests of a new product or process.

Question 2d: How well does R&D activity planning incorporate performance indicators? (Question modified by adding the word "R&D")

Grade 5: A multi-year planning process identified critical decision points, key decision milestones, "graduation criteria" (defines when the R&D activity will transition from the Federal to the private sector for commercialization or further research), and an end-point for DOE-supported technology development and deployment. The R&D activity planning leads to well-documented, quantifiable annual performance milestones or accomplishments, and mid-term goals and milestones or research outputs that are clearly linked to the program's long-term goals. Objective baselines exist for key technical parameters needed to quantify the state of technology at the point in time the R&D activity planning begins. Where appropriate to the research activity, those parameters lend themselves to use as trend indicators that can be measured relative to those baselines.

***Note**: Multi-year budget assumptions and external factors are explicitly spelled out in the planning process, and the R&D activity plan is accompanied by a statement of mid-term and long-term goals. R&D activity progress is measured against the multi-year plan; performance is measured against performance indicators; and, performance is used as a criterion in out-year budget requests.*

(EM example: EM R&D activities are incorporated into the cleanup contractor's baseline and are linked directly to the schedule.)

Grade 4: The R&D activity plan has well-specified (and documented) annual milestones, interim outputs, and long-term/final outputs. Most of the performance measures are quantifiable and, where appropriate, trends can be established relative to a baseline, but a few of the indicators are difficult to quantify and verify. The linkages between various milestones and their corresponding outputs or expected outcomes are clearly established, and the multi-year budget assumptions underlying the projected progress can be explained. R&D activity progress is measured against the multi-year plan; performance is measured against performance indicators and is used as a criterion in out-year budget requests.

Grade 3: Performance measures for the R&D activity plan include annual milestones and multi-year milestones and outputs, but some of the measures are not well specified (e.g. they lack a multi-year timetable, a well-defined baseline, or are vague in some way). Linkages between milestones, outputs, and long-term goals are difficult to explain. Performance trends (where applicable) that can be measured against a baseline are limited.

***Note**: The performance results for some R&D activities are easy to measure in fixed increments of time (performance trends). Other R&D activities are of a threshold nature; an event occurs or does not occur to advance or redirect the research.*

Grade 2: Some key performance metrics for the R&D activity plan are missing, and the linkage of annual milestones to mid-term and/or long-term goals is not clear. Annual outputs (milestones) are clear but not quantifiable, and therefore can serve as milestones but not as indicators of performance trends. The long-term goal is not quantifiable.

Grade 1: Annual outputs for the R&D activity plan are not clear or quantifiable (i.e. cannot be considered as "milestones"). No performance trend indicators or baselines exist. Expected final outcomes are unspecified or unclear.

Definitions for question 2d:

Output: A quantifiable result or accomplishment of the R&D activity.

Milestone: A clearly defined research accomplishment contributing identifiable progress toward the desired output(s) or goals of the R&D activity. The milestone is clearly defined, so that the R&D activity can be said unequivocally to have or have not met the milestone.

Baseline: The starting point for measuring progress, and making R&D investments. The baseline is the reference value (fixed base) of the parameter being tracked (e.g. battery watt-hours per kilogram, or cents per kilowatt-hour price of an energy supply technology) at the time when the R&D activity is initiated that will be used as a performance trend indicator

Performance trend indicator: A parameter representing some quantifiable aspect of the R&D activity that is consistent from year-to-year, allowing quantitative measurement of progress over time relative to a baseline, in the same units as the baseline is defined (see baseline definition).

Interim output: Description of planned progress during the course of the research that is clearly related to the long-term program goals. Usually an interim output would be a more holistic or integrated description of the state-of-the-art than a single annual milestone. An example of an interim output sold as a market product is a fiber-reinforced composite truck bed now offered by General Motors. This product was an interim result from ongoing research aimed at proving the concept that large, monolithic structures (e.g. truck bodies) made of fiber-reinforced composites could be produced cost effectively at automotive volumes. As a result, General Motors now offers, as an option on one of its trucks, a fiber-reinforced all-composite truck bed. The truck bed is market-competitive because the glass-fiber reinforced bed saves energy by reducing weight; reduces parts count; simplifies vehicle assembly; and, eliminates the need for a bed liner.

***Note**: Even though the progress represented by the interim output (e.g. fiber reinforced composite truck bed) may be sufficient for early or niche markets, the interim output itself is not sufficient for graduation and the resulting expected outcomes.*

Decision points: Clearly-defined stages in the development process where a decision can be made to go on to the next phase, stop, change direction, or focus (down-select) the technical pathways being developed.

Graduation criteria: Clearly defined (and almost always quantitative) thresholds of key performance indicators that, when reached, would allow further development and commercialization to be turned over to the private sector under expected future market and policy conditions.

End point: Clearly defined (and almost always quantitative) thresholds of key performance indicators that, when reached, would translate into having reached the activity's long-term goal and would justify ending the activity and "declaring success."

Question 2e: How well does the R&D activity plan incorporate "off ramps" and a clear end point?

Grade 5: Off-ramps are addressed and identified in objective terms. A clear end point is identified and tied to an R&D activity plan schedule.

(NNSA example: The Office of Defense Nuclear Nonproliferation is conducting R&D activity in support of an Air Force priority. This priority is funded at varying levels from year to year, which causes the end points to shift. The end points may also shift because of externalities, vice failure to perform internally.

(FE example: Under the SECA fuel cell program multiple industry teams are selected to develop concepts with very specific performance targets by clear end dates. Teams not meeting these criteria at the specified decision points (budget periods) will be subject to termination via provisions included in awarded cooperative agreements.)

Grade 4: Off-ramps are addressed and identified in objective terms. End point is addressed, but the "when" is not identified.

(NE example: The Generation IV Nuclear Energy Systems Technology Roadmap currently under development is down-selecting 19 candidate concepts to 6 to 8 concepts.)

Grade 3: The R&D activity plan identifies off-ramps and end points, but lacks specificity on the milestones that would trigger off-ramps/termination of the R&D activity.

Grade 2: Unclear definition of off-ramps and no clear tie to schedule.

Grade 1: Off-ramps are not addressed/provided. A clear end point is not available.

Definitions for Question 2e:

<u>End point</u>: The expected conclusion of successful research efforts, also referred to as the "graduation" point. An end point includes a clear statement of the desired output at the time of completion. [End point is the equivalent to the term "termination point," but is less value-laden]. An end point can also be a determination to prematurely end the R&D activity because technology milestones have been, or cannot be, reached with the knowledge that is available or reasonably anticipated.

<u>Off-ramps</u>: Also referred to as "decision points," "critical path milestones," or "interchanges." Off-ramps are points in the R&D activity at which it is important to reassess progress to date. Re-assessments typically include direct evaluation of research results, comparison of research results to results being achieved in competing lines of research (e.g., "down-selecting,") and any changes in external factors (i.e., market conditions, policies) that might change the ultimate value of the research, if successful.

<u>Industry</u>: For the Environmental Management Program, "Industry" means the clean-up contractors at the sites, and "industry's needs and schedules" relate to the clean-up baselines (requirements and schedules).

Question 2f: To what extent is the R&D activity plan the result of a competitive merit-based process and subject to an external review?

***Note**: The Department will use a 5-3-1 scale for clarity and ease of grading.*

Grade 5: External peer reviews by a committee of independent experts reviewed the R&D activity plan and contributed to the development of merit selection criteria. There is a clear record of how expert comments were addressed and a clear rationale for selection exists.

***Note**: The National Academy of Science is a well-known and well-established entity and has standing committees, but when a particular study is initiated, an assembly of selected experts is added to the panel. Balance is achieved by having a panel representing the spectrum of stakeholder viewpoints participate in the review.*

(Example: A Federal Advisory Committee or subcommittee, or an NAS/NAE Committee or subcommittee conducted the peer review.

(NE example: The NERI R&D activity was recommended by the NAS, and its technical progress is being reviewed by a NERAC subcommittee. The NERAC subcommittee also contributed to the development of the merit selection criteria.)

Grade 3: DOE experts (from inside and outside the program area) formed a committee to review the R&D activity plan independently and recommended it prior to a competitive, merit-based process. Explanation/rationale for the R&D activity plan is provided.

Grade 1: No peer review or competitive merit-based processes exist.

Definition for Question 2f:

External: Conducted by an agency outside the Department of Energy.

Question 2g: What is the expected number of years to commercialization?

The expected number of years to commercialization is __________.

***Note**: This will be a "fill-in-the-blank" question and will not be subject to scoring*

Definitions for Question 2g:

Commercialization: The term "commercialization" refers to the point at which the final output technology is ready for significant market sales in its respective market. This can be long after the end of the research period, as commercialization can take years of additional private sector research, product development, or market development. While interim technology improvements (i.e. "interim outputs") may be incorporated into commercial products, usually on a niche or limited market basis, this question addresses only the commercialization of the final research technology.

(Example: Batteries, often developed in part with DOE funding, are found in all automobiles, and some more advanced batteries are found in limited production, small hybrid vehicles; however, current commercial batteries are not sufficient to support cost-competitive commercial hybrid vehicles representing the range of popular vehicle sizes in the U.S. under U.S. driving conditions.)

(NE example: The Nuclear Power 2010 R&D activity is demonstrating new licensing processes and advancing promising designs that can be constructed and commercially deployed by 2010.)

***Note**: Some technologies might be intended for Federal applications only (e.g. cleanup technologies, NE's process for electrometallurgical treatment of spent nuclear fuel.) Commercialization, as it pertains to these technologies, is therefore defined as the time at which a technology is available for implementation or purchase from a commercial vendor, as opposed to broad market availability.*

Question 2h: Is this R&D activity basic, applied, demonstration or development?

***Notes**:*

1. *This question will be treated as a check-box, and will not be subject to scoring.*
2. *If the R&D activity does not fall within the definitions for the following terms, please explain.*

ÿ Demonstration

ÿ Development

ÿ Applied Research

ÿ Basic Research

Definitions for question 2h:

***Note**: OMB definitions, where available, are provided.*

Basic Research: Basic research is defined as systematic study directed toward fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind.
(OMB definition)

Applied Research: Applied research is defined as systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met. (OMB definition)

(Example: Methane Hydrate research)

Basic Research contrasted with Applied Research: Basic research is the expansion of knowledge that may benefit the U.S. in future years, while applied research is based on solving specific problems in a definable time frame.

Development: Development is the systematic application of knowledge toward the production of useful materials, devices, systems, or methods, including design, fabrication, and improvement of prototypes and new processes to meet specific requirements. (OMB Definition)

(Example: Stationary Fuel Cells)

Demonstration: The operation and evaluation, at commercial or semi-works scale (see definition below), of processes, technologies or systems to assess: technological effectiveness; costs to verify and quantify feasibility of construction; operability; maintainability; durability; and economics, prior to decision-making on further replication, deployment, or marketing.

(Example: FE's Clean Coal Power initiative)

Semi-works Scale: Operation on a limited commercial scale to provide final tests of a new product or process.

DOE Proposed new 2i: What is the extent of technological risk inherent in the research?

Grade 5: Research addresses fundamental technological breakthroughs hinging on one or more unproven areas of inquiry.

(FE example: For natural gas hydrates, fundamental technological breakthroughs are required in the areas of crystallography, pore water, chemistry, biochemistry, and temporal history properties to understand sea floor stability concerns. Added details available at (http://www.netl.doe.gov/scng/hydrate/pdf/99hydrate.pdf))

Grade 4: While basic approach has been proven, substantial work remains on developing the technology; ultimate technology costs are difficult to assess at this point in the research.

(NE example: The basic approaches for the separation of various components of spent nuclear fuel have been developed; however, substantial work remains to determine the effectiveness of these approaches as applied to new fuels.)

Grade 3: While the technology has been proven, work remains on developing improvements to multiple aspects of the technology's performance, and in reducing technology costs by 25 percent or more.

(Example: Component must be able to survive 3,000 hours of continuous use under field conditions; refueling/maintenance required only every 100 miles; Occupational Safety and Health Administration and other safety standards must be met; costs at full production run would have to be reduced to $1 per unit.)

Grade 2: Only a few technology performance improvements are required, and these pose limited technological challenge; remaining needed cost reductions for widespread commercialization are under 25 percent.

Grade 1: The technology being developed is a modification of existing technologies with substantial commercial product experience, and no major further improvements or cost reductions are required.

Question 3a--R&D Activity Performance: Provide an equivalent dollar unit of energy saved or generated or other benefits (actual and anticipated) to indicate the R&D activity's effectiveness, efficiency and benefits.

Information to be provided in response to this question will be:

1. Actual metric at the time the R&D activity is undertaken.

2. Anticipated metric at the completion of the R&D activity.

Note: *Key metrics are provided below for each program office. Due to the unique program office missions, appropriate metrics vary from office to office.*

FE Metrics:

Reduced environmental emissions (by type)

Reduced costs (due to less expensive electricity, fuels and Hydrogen production)

- Gas--dollars per million BTUs
- Electricity--cents per kilowatt-hour
- Oil--dollars per barrel

Additions to domestic economically recoverable oil and gas resource base

EERE Metrics:

Energy savings (by oil or other fuel type)

Increased domestic production

Energy cost savings (defined as outputs from the R&D activity itself as appropriate)

Reduced environmental emissions (by type)

Non-energy benefits (e.g. productivity, health and safety):

<u>*Explanation*</u>*: Non-energy benefits from energy-related R&D are often a critical consideration by partners/consumers.*

Note*: The baseline should be an EIA/business-as-usual case absent DOE technologies.*

NE Metrics:

Reduced environmental impacts: For example, transmutation of nuclear waste has the potential to reduce in approximately 1,000 years the radio toxicity of spent nuclear fuel to that of the original uranium ore. Without such treatment, the time span would be at least 300,000 years.

Reduced costs (over competing energy technologies)

NNSA Metrics:

Improvements to the nuclear stockpile

Percentage of active stockpile weapons that are certified to be safe and reliable (classified S/RD)

Improved technical capability for national security missions

Number of nonproliferation and counter-terrorism technologies developed

National security products (weapons, sensors) delivered on time

<u>Explanation</u>: NNSA will select R&D activities based on support to other agencies' national security operational missions. Requirements and needed improvements in capability are provided by the Department of Defense, the Intelligence Community, and the Office of Homeland Security.

EM Metrics:

Risk Reduction

Schedule Acceleration

Cost Savings

<u>Explanation</u>: EM will select R&D activities based on their anticipated relative risk reduction, schedule acceleration, or cost savings. EM will obtain this information from estimates provided by the prime cleanup contractor or technology developers as appropriate. It should be noted that reliable estimates can be determined only for mature technologies. Estimates for alternative approaches and immature technologies will be based on standard engineering practices and will have a relatively high level of uncertainty.

DOE Recommended Scoring Levels for R&D by Program Office

A. Appropriate Reporting Level for Nuclear Energy (NE)

A program is a coherent set of sub-activities, which may include supporting R&D activities and facility operations and maintenance, and which has an overall objective of providing new technologies to meet DOE's strategic goals. In that programs often consist of a group of interrelated activities, reducing or eliminating one sub-activity can cascade and lead to unintended consequences in other parts of the program; hence, reporting must be at the program level to prevent this from happening. No matter what level is determined to be appropriate, this level must be carefully defined at the outset of reporting to ensure that meaningful information is generated.

Reporting at the sub-program level will lead to an excessive burden on the NE program staff to produce the necessary information and to an excessive burden for those that must review the reports. Within NE, there are several hundred sub-activities in the applied R&D programs and for many of these the proposed scoring system would not apply. While NE has deliverables for all identified sub-activities, collecting data at the sub-activity level to fulfill the proposed scoring system would lead to a meaningless collection of information that would be difficult, if not impossible, to interpret and which would lead to faulty decisions.

B. Appropriate Reporting Level for Fossil Energy (FE)

The Fossil Energy budget structure evolved in response to a variety of external and internal drivers, and items at the same level in the structure are not necessarily similar in terms of funding and scope. Thus, rather than trying to find a Aone-size-fits-all@ budget level appropriate for R&D scoring, emphasis was placed on defining R&D activity areas such that:

- $ The size of the R&D area is large enough to justify the interagency efforts inherent in the scoring process
- $ The R&D area is sufficiently focused so that benefits can be developed and easily communicated

As a result of this process, the following areas***** were chosen:

Clean Coal Power Initiative Innovations for Existing Plants (Environmental Control Technology) Advanced Coal Power Systems (IGCC, PFB, Turbines) Fuel Cells (AR/Systems/Hybrids) Innovative System Concepts (e.g., SECA Fuel Cells) Sequestration Fuels Advanced Research (Materials/Utilization Science)	Natural Gas Exploration and Production Natural Gas Hydrates Natural Gas Infrastructure/Storage Natural Gas Processing Oil Technology Exploration and Production Oil/Gas Environmental Protection

***** Some areas, particularly in the gas and oil area, may be affected by the ongoing FE Strategic Review

Note that the Clean Coal Power Initiative (CCPI) is a much larger R&D activity area than others in the table. It is funded at $150 million in FY 2003, and because it is a documented Presidential priority, is likely to be funded at a high level in FY 2004. There are no defined sub-levels below the CCPI level B just projects. If large projects are awarded in the future (first selections due at the end of FY 2002,) it may make sense to incorporate these into the scoring system.

C. Appropriate Reporting Level for Energy Efficiency and Renewable Energy (EERE)

Complete the R&D criteria scorecard at a program or sub-program level. EERE is in the process of reorganizing into 11 programs (FY 2003 budget is organized along five sectors or programs). These programs represent integrated areas of R&D effort. In most cases, there is more than one discernible research area within a program and in these cases it can be meaningful to break out these subprogram areas for reporting purposes. While each sub-program or research area is, in turn, supported by a number of research projects, these projects are portions or elements of an overall research strategy, and not discrete research areas in their own right. As a result, many of the criteria (e.g., public benefit provided) would be difficult or impossible to assign at the project level.

D. Appropriate Reporting Level for Environmental Management (EM):

EM will report at the "sub-activity" level. It is one level lower than described in the budget request and is the only level that can be fully responsive to the criteria identified in the Applied R&D Investment Scorecard. At this level, it is estimated that EM will report on 15-25 activities.

The "sub-activity" level is directly related to the objective of the research activity, which is to improve the performance of a specific DOE cleanup activity. Any activity below this level would only partially address that objective and would not provide a measure of performance against the overall EM objective.

E. Appropriate reporting level for National Nuclear Security Administration (NNSA):

NNSA recently produced its annual Future Years Nuclear Security Plan (FYNSP) for fiscal years (FY) 2000-2007, as required by the FY 2000 National Defense Authorization Act. The FYNSP contains approximately 10 Congressional control levels that contain NNSA applied R&D, which NNSA proposes to use for criteria application. Several of these control levels are, in fact, organized as projects. The remaining control levels are project-like, and constitute the appropriate level for this analysis and scoring activity.

NA-10 (Defense Programs)

DSW R&D activities are conducted in the following order: maintain system certification; assess the safety and reliability of the nuclear weapons stockpile as a basis for the Annual Certification to the President; respond to emerging problems or issues including resolution of Significant Finding Investigations; support directive schedules; develop modern physics and engineering baselines; perform development and engineering to support refurbishments approved by the Nuclear Weapon s Council; develop refurbishment technologies; maintain the ability to respond to requirements; and, develop the capability to refurbish old weapons and/or design new weapons as required.

1. **Directed Stockpile Work (DSW) R&D** FY 03 $467.2M

Campaigns are multi-year, multi-functional efforts to provide the capability to address current or future questions or issues concerning the nuclear weapons stockpile, by employing the best scientists and engineers and using the most advanced sciences and technologies. Campaigns focus research and development on clearly defined deliverables; they have defined milestones, specific work plans, and specific goals. Campaigns develop and maintain special capabilities and tools needed for continued certification of the nuclear stockpile, now and into the future, in the absence of underground nuclear testing

2. **Science Campaigns** FY 03 $235.5M

3. **Engineering Campaigns** FY 03 $239.4M

4. **High Energy Density Physics Campaign** FY 03 $451.8M

5. **Advanced Simulation & Computing Campaign** FY 03 $724.9M

6. **Pit Manufacturing and Certification Campaign** FY 03 $194.5M

NA-20 (Defense Nuclear Nonproliferation)

Reporting level for Nonproliferation and Verification R&D will be the three programs reported in the FY03 budget request, which requested the following amounts in FY03:

Proliferation Detection	FY 03 121.5 M
Nuclear Explosion Monitoring	FY 03 89.4 M
Chemical/Biological National Security	FY 03 69.0 M

These program areas are analogous in scope and funding level to the project areas reported by Defense Programs (Campaigns). These program areas are consistent with the NNSA multi-year Planning, Programming, Budgeting and Evaluation System (PPBES). Evaluating the R&D criteria at this level will allow budget management decisions to be made at a sufficiently high-level to influence NNSA future PPBES processes.

NA-30 (Naval Reactors)

Naval Reactors will have one category for evaluation.

Naval Reactors has a single, focused mission--to provide the Navy safe, efficient and militarily effective nuclear propulsion plants. The priorities of the Program are to support the reactors in the operating fleet in support of National Security missions (40% of the major combatants are nuclear powered), design and develop new nuclear propulsion plants to meet current and future National Security requirements, design and develop upgrades to current designs, and to safely dispose of the reactor plants at the end of ship and core life.

Questions that Environmental Management (EM) Proposes for Elimination:

Question 1d: To what extent does the R&D activity support the Federal policy goals compared to other policy alternatives such as legislation or regulation?

The premise of this question, "can the problem be better solved by a technical solution or by legislation," does not apply to EM. The clean up of contaminated DOE sites is almost totally driven by regulations and legislation or agreements that set clean-up standards and schedules. R&D activities are required in many cases to allow DOE to meet the established clean up levels in a safe and effective manner. While legislation, regulations and agreements could be modified to lessen these clean-up standards, in almost all cases significant technical studies would be required to support the decisions.

Question 2c: What is the level of industry cost sharing for the program?

This question is not directly applicable to the EM program. The Department's cleanup program comprises more than 40 percent of the entire remediation market in the United States, and many of DOE's cleanup problems are unique. Since the mission of the EM program is to clean up DOE sites contaminated during the development, testing and production of nuclear weapons, EM must ensure that cleanup solutions exist and that the United States maintains the means and ability to effectively to clean up severely contaminated sites, including those with radioactive contamination. EM and industry's proper roles in funding technology R&D fall into three broad models. Because no single formula applies to these three broad models, and because EM is a major (and in some cases, the only) user of a technology-based product, the value of question 2c is limited for scoring EM R&D activities. The three models are as follows:

1. For technology areas in which no direct market driver exists to develop a competitive radioactive waste cleanup industry within the U.S., and therefore little, if any, basis exists for expecting industry cost sharing, a company would require a prior commitment to perform work using this developmental technology, plus downside insurance against technology failure, before it would be willing to co-fund R&D.

2. For technology areas in which relevant existing commercially available technologies can be adapted, with DOE help, to nuclear cleanup (e.g., hardened for radioactive environments) in order to improve performance or cost in cleanup projects, commercially available technologies that have had no support from EM are adapted, with EM support, to the EM mission; in these cases, industry's contribution to R&D may range up to 100 percent.

3. For technology areas that are relevant to EM-relevant cleanup *and* valuable in non-DOE projects (e.g., decontamination and decommissioning of commercial reactors), an expectation of industry co-funding is most relevant, and a meaningful commercial capability within the United States should be expected.

Questions that the National Nuclear Security Administration (NNSA) Proposes for Elimination:

OMB Question 2c: What is the level of industry cost sharing for the program?

Explanation: This question generally does not apply to NNSA activities.

OMB Question 2g: What is the expected number of years to commercialization?

Explanation: This question is not applicable to most NNSA activities, as they are generally not suitable for commercialization, and the Federal government is the only customer.

Questions that DOE Recommends be modified for Environmental Management

OMB Question 2g: What is the number of years to commercialization?

Question 2g as modified for EM: What is the expected number of years to "commercial technology availability?"

Explanation of Proposed Modification: EM requests that "commercial technology availability" be used instead of "commercialization." The market for environmental cleanup is relatively small, and DOE comprises over 40 percent of that market. Further, many products used by EM have limited use outside of EM, so these products will not meet the definition of the term "Commercialized" (e.g. actively marketed by a private vendor); however, Environmental Management does need the technologies developed to the point where the clean-up contractor can buy the needed application from the vendor.

Questions that DOE Recommends be modified for the National Nuclear Security Administration (NNSA)

OMB Question 2b: How well does the R&D activity's planning and prioritization incorporate industry involvement?

Question 2b as modified for NNSA: How well does the R&D activity support the national security objectives of the Administration?

> Grade 5: The R&D activity fully supports the national security objectives of the Administration.
>
> (Example: R&D directly supports results or recommendations from the Nuclear Posture Review.)
>
> Grade 3: The project partially supports the national security objectives of the Administration.
>
> (Example: R&D supports plans and/or roadmaps being initiated by the Homeland Security Council.)
>
> Grade 1: The project does not support the national security objectives of the Administration.

Explanation of Proposed Modification: Industry involvement does not apply to most NNSA activities.

OMB Question 3a: R&D Activity Performance--Provide an equivalent dollar unit of energy saved or generated or other benefits (actual and anticipated) to indicate the R&D activity's effectiveness, efficiency and benefits.

Question 3a was modified for NNSA; see NNSA metrics at page 24.

Explanation of Proposed Modification: Energy saved or generated is not applicable; NNSA provided alternative metrics, listed at page 24.